Belgeo
Revue belge de géographie

1-2-3-4 | 2000
Special issue: 29th International Geographical Congress

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Electronic version
URL: http://journals.openedition.org/belgeo/13936
DOI: 10.4000/belgeo.13936
ISSN: 2294-9135

Publisher:
National Committee of Geography of Belgium, Société Royale Belge de Géographie

Printed version
Date of publication: 30 December 2000
Number of pages: 103-114
ISSN: 1377-2368

Electronic reference
Henri Nicolaï and Yola Verhasselt, « Health and tropical geography », *Belgeo* [Online], 1-2-3-4 | 2000, Online since 12 July 2015, connection on 19 April 2019. URL : http://journals.openedition.org/belgeo/13936 ; DOI : 10.4000/belgeo.13936

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1 The geographical analysis of a tropical area includes nearly always an important part related to health aspects, as determinants of its history, demography and sometimes localisation of its population. Is this concern a direct effect of the characteristics of the tropical environment or is it a consequence of the type of civilisation, in other words of the shortage of technical means of most of the populations of this area? In reality there is a combination of both.

The specificity of the tropical world with regard to health

2 At the time where the concept of 'tropicality' in human geography is questioned (for physical geography, there is less concern), it is logical to wonder if a tropical geography of health exists. The interest is increased because of the probability of spatial extension (in latitude and altitude) of tropical diseases due to global climatic warming (Carcavallo & Curto de Casas, 1996).

3 The concept of 'tropical medicine' became ambiguous (in fact, in several cases it replaced the expression 'colonial medicine'). Those diseases related directly to the tropical environment (such as many vectorial diseases) are in fact influenced by socio-economic conditions responsible for their persistence and/or re-emergence. In reality various aspects of health in the tropical world are related to poverty and underdevelopment. This is the case for example with malnutrition, food deficiencies, persistence of infectious parasitic diseases. The insufficiency of public health care systems is largely responsible for the situation, also for the shortcomings of international vaccination campaigns resulting in high infant and child mortalities due to infectious diseases such as measles.

4 AIDS is a pandemic affecting more seriously the tropical world, particularly Africa, but this is by no means a consequence of the natural environment.

5 The tropical countries demonstrate a great variety as to their position in the health transition due to the large variety within the development process (Caldwell, 1993). The

epidemiologic transition involves the evolution from a stage of predominantly infectious and parasitic diseases towards a stage of degenerative and man-made diseases. The speed of change varies between Western countries (long transition) and developing countries characterized by a delayed model. Several middle-income countries are experiencing a rapid change, for example Thailand. Here health indicators, such as life expectancy or infant mortality, improved quickly. Infectious diseases and nutritional deficiencies decreased, while mortality from heart diseases and malignant neoplasms increased (Phillips & Verhasselt, 1994, p. 17). Also 'western' ailments such as diabetes, obesity and hypertension are expanding. Population ageing is a growing concern, also in the developing world (Willaert & Verhasselt, 1998).

6 It seems very difficult to distinguish in tropical health the risks due to the natural environment from those resulting from economic and political factors, such as poverty, lack of sanitation, inequity of spatial distribution of health care, decrease of public expense (as a consequence of structural adjustment, for example) and rapid urbanization.

Former health disparities recently reinforced

7 One may wonder if the health disparities between the developed and the developing world are not due mainly to the technical backwardness accumulated by tropical countries for two centuries. This view is illustrated by P. Gourou in his book 'Terres de Bonne Espérance' (1982).

8 In the Middle Ages and even in the early Modern Times, Europe was devastated by infectious diseases (measles, diphtheria, smallpox, tuberculosis), by extensive epidemics (influenza, plague, cholera) which were sometimes pandemics; leprosy was also present. In some regions there were malarial fevers. Because of the urban poor hygiene conditions, the rural environment appeared to be more healthy.

9 Does this mean that at that time there was no significant health difference between temperate and tropical countries and that the gap has become larger only with progress in hygiene, food supply and medicine in the 18th century and especially in the 19th century? There is no doubt that the gap has increased since such progress appeared at first in temperate countries. The fact that this gap existed in the past looks likely given the importance and the frequence in tropical countries of diseases such as malaria, yellow fever, schisto-somiasis and the many filariases adding further to the infectious diseases which affect both temperate and tropical countries.

10 Clearly tropical insalubrity does have different degrees according to the countries concerned. Africa should be distinguished from America and Asia. It seems for instance that America, on the Europeans' arrival, was less malarial than Africa. Some even claim that malaria (falciparum) was imported by African slaves; others rather think that American mosquitoes are less effective to transmit the parasite because of their behaviour or requirements. In any case, Africa seems to have accumulated the risks.

11 Moreover one should take into account the fact that, for some tropical areas, the colonial period was the end of isolation which brought local populations in contact with imported diseases or, even more simply, in more frequent contact with each other, which led to the exposure to more virulent infectious agents and to their diffusion. Of course this also occurred, even in the temperate regions of America for precolombian populations, previously to Africa. The end of isolation was a determining factor for the great epidemic

of sleeping sickness of the early 20th century in Central Africa and for several epidemics of smallpox and yellow fever.

12 Beyond the external factors which could 'reveal' or favour certain diseases, the tropical world, even today, shows indeed the largest variety of diseases that can be considered as 'geographical', i.e. related to the natural environment (yellow fever, malaria, dengue, various filariasis, trypanosomiasis, etc.).

The persistence of tropical specificity

13 Some diseases develop in the tropical environment, frequently all year long, under favourable conditions, sometimes even without existing elsewhere (this is the case for sleeping sickness, which is typically African because the vector area is limited to tropical Africa).

14 One may also wonder if a warm and humid environment is not more favourable to the swift emergence of new viruses. Do isolated and sparsely populated areas of the tropical world (in the equatorial forest for instance) not contain in their animal populations virus reservoirs likely to be transmitted to man and to cause serious epidemics (such as Ebola virus)?

15 Eradication of endemic diseases in tropical countries is subject to more difficult conditions because of the numerous sites suitable to vector insects or intermediate hosts of viruses, mono- or pluricellular parasites and to their multiple varieties.

16 There is a high risk of resurgence of such diseases; slackening efforts makes all results fall down and makes a new start necessary. The appearance of chemio-resistance among parasites or vectors increases the risks all the more since medicines or insecticides have not always been distributed or used appropriately.

17 Let us look into the case of three re-emerging diseases which remain a threat in the tropical world: malaria, dengue, Chagas' disease.

18 *Malaria* may appear outside the tropical world in any place where summer is warm enough and where there are at that season many or extensive water surfaces. But in these extra-tropical areas, it is transmitted only during a period of the year and can be eradicated today without too many difficulties. On the contrary, in tropical regions, the transmission conditions are favourable all year round, but in an uneven way. The struggle against vectors is particularly difficult because there are too many shelters. Moreover men are often not sufficient in number to ensure and maintain a total control of the territory.

19 At the end of World War II, when DDT became available, eradicating malaria was thought to be possible in the whole tropical world by combining the struggle against the vector and the administration of effective and relatively cheap drugs (as those based on chloroquine). Malaria disappeared from parts of South and South-East Asia. The operation was known to be more difficult in Africa but there were chances of proceeding progressively.

20 After 1970 came the disillusion. A chain of circumstances led to a backward move. They are known: appearance of strains of Anopheles resistant to insecticides, appearance in South-East Asia of chloroquine-resistant Plasmodium falciparum strains which spread in Asia and in a large part of Africa, reduction in struggle campaigns against vectors due to

budgetary constraints (increase in oil prices in the 1970s; structural adjustment imposed by the IMF (International Monetary Fund) in the 1980s and 1990s; sometimes cut in public health expenses to cope with the growing needs of the army engaged in civil wars), anarchic development of urban areas lacking any effective control of water sanitation. In Africa, armed conflicts and the resulting wide movements of refugees have weakened the resistance of entire populations, destroyed health facilities, and brought displaced people in contact with other strains.

21 In India, a slackening of efforts, after important results had been achieved, has led to the resurgence of the disease. Successful malaria control in India (essentially through spraying campaigns) reduced indeed the prevalence to about 100 000 in 1965 (from 70 millions before independence) (Learmonth, A. 1988, p. 208). During the following years an upheaval of the number of cases has been observed, partly due to reduced control measures, to vector resistance to insecticides and parasite resistance to the classical drugs (chloroquine) and to an increase of urban malaria. Hence a re-diffusion took place in India (Akhtar, 1995).

22 Malaria is now again one of the main scourges of humanity. 'Roll Back Malaria' is a major challenge being taken up today by the World Health Organisation.

23 In this field, Africa appears as the most sensitive action scene. While the malarial death rate, which had fallen down in the whole world since the 1940s, keeps on dropping, it has experienced a spectacular rise on the African continent, south of the Sahara (216 per 100,000 inhabitants in 1930, 184 in 1950, 107 in 1970 but 148 in 1980 and 165 in 1997) before regaining its level of fifty years ago (OMS, 1999, p. 56). In Africa, malaria is the main factor of infant mortality. It is also the indirect cause of many deaths as it weakens the body and worsens the effects of infectious diseases and malnutrition situations. Its economic cost (loss of production, inhibitive effect upon foreign investments, etc.) was estimated at the equivalent of 1% of the GDP and up to 5 or 6% for countries like Kenya and Nigeria (OMS, 1999, p. 57). The cost of treatment for the sick puts a heavy burden on the budget of rural families. Moreover poverty excludes many of them from treatment. Therefore malaria appears as a cause as much as a consequence of underdevelopment.

24 The WHO, World Bank, UNDP and UNICEF have decided to join their efforts in order to help national governments and encourage non-governmental associations as well as different foundations to take part in eradication strategies. All these projects (for example the diffusion of insecticide-treated bednet programmes) need the participation of the populations concerned which have to be informed and convinced.

25 *Dengue*, another disease peculiar to warm (not exclusively tropical) countries, is also extending in the tropical world partly because of the above-mentioned factors. This fever is related to a virus also transmitted by a mosquito (mainly Aedes aegyptii). Its acute form, haemorrhagic fever, can be fatal (20,000 deaths a year). Since the 1980s its eruption in the whole tropical world and especially in America due to a proliferation of Aedes aegyptii has been so significant as to be subject to a special programme by the Panamerican Health Organisation (PAHO). Here too we are witnessing a stage of re-emergence as in some regions we have come back to the situation of 1950 (Pinheiro & Corber, 1997). Venezuela suffered several epidemics in 1989 and 1995 (Brightmer & Fantato, 1998). The Aedes' proliferation is linked to a lack (or stop) of mosquito control and to the deficiency of urban sanitation in a stage of rapid urbanization. The lack of an adequate water distribution system or the existence of an irregular and non-permanent

distribution system involves the existence of numerous small individual reservoirs which are favourable breeding places for mosquitoes.

26 *Chagas' disease* is the third example of a re-emerging disease. This very old American disease (traces of it would have been found in mummies from Chile as far back as the 5th century B.C.) has become the most important parasitosis in Tropical America where its socio-economic effects would exceed those of malaria, leish-maniasis and schistosomiasis combined (Dujardin, 1999, p. 7). In this American trypanosomiasis the trypanosoma (Trypanosoma cruzi) is transmitted to man by heteroptera haematophagous insects (Triatominae), probably associated at the origin to wild mammals (forest species), but which adapt so easily to human habitat (domestic species). These species live in rather stable environments and their populations do not vary in the same proportions as those of mosquitoes which highly depend on climatic conditions. The Triatominae vectors live in the walls and roofs of houses built with non-durable material (adobe, pise, cob, thatch, vegetal material). The vectors can also bite dogs which then will host the parasite.

27 The 'domestic' Triatominae follow humans in their migrations and can spread beyond their natural ecological boundaries. Therefore the diffusion of the disease in America is linked to the colonization of new regions and to the migrations of rural families (Curto de Casas & Carcavallo, 1995).

28 *Other diseases* are re-emerging. Sleeping sickness (African Trypanosomiasis) is essentially a rural disease. In the Congo, for example, important foci still exist. During the last twenty years, there is no systematic eradication programme. In 1998 more than 27,000 new cases were registered (Fometro, 1999). This figure corresponds to the situation of 1920-1930. The mobile medical teams could only reach 10% of the population at risk (this figure was 85% before 1960). There are no large epidemics as in colonial times, but local small epidemics exist in the Congo, Angola, Uganda and Sudan.

29 Obviously for the study of the distribution and effects of great tropical endemic diseases, other factors than the natural environment should be taken into account. For instance, a low population density makes people more sensitive to the presence of onchocerciasis. The most harmful effects of this parasitosis depend mainly on the number of bites suffered during a certain period of life and consequently on the relation between the number of people and of vector insects present (Hunter, 1966).

30 Malnutrition can worsen the effects of epidemics. On the contrary some conditions of malnutrition can be related, at least indirectly, to the presence of parasitic or infectious diseases. In Africa the presence of trypanosomiasis, which affects animals as well as humans, and which consequently impedes cattle breeding, may be a factor of proteic malnutrition.

Epidemiological problems related to large development schemes

31 This theme is not recent since it dates back to about a hundred years when the large building sites (Panama Canal, railways) led to tremendous epidemics (especially malaria, diarrhoea, yellow fever) which affected both European and indigenous workers (among the latter there were many people recruited outside the region). Later malaria expanded in plantations in Malaysia, then among labourers coming from inland Africa to the coastal regions of West Africa (cf. for Nigeria, Prothero, 1965).

32 The large development schemes, such as the Gezira Scheme, which were undertaken in African countries already before World War II, caused health problems, particularly the diffusion of schisto-somiasis into the new irrigation systems. The big hydroelectric dams also caused an expansion of malaria and even of sleeping sickness.

33 By altering the environment, agricultural development schemes may induce favourable conditions to the vectors or the disease agents. Ignoring the tropical characteristics would be a mistake or a danger. A thorough epidemiological study was carried out in the low region of the Imbo (Ruzizi valley) in Burundi (Coosemans, 1989). This region, which had long been neglected, located at the foot of very populated territories, has been subject to various developments on both sides of the Congo-Burundi boundary since the late 1950s. On the Congolese side, big projects were created, partly based on irrigation and concerning sugar cane, cotton, then rice.

34 Their success was irregular or uncertain. But the population in the plain increased significantly by immigration from mountain regions with a low rate of malaria. So there were real risks of malaria extension. Fortunately the relatively sparse rains have reduced the transmission of the disease.

35 The research carried out in the Burundese part, where food-producing cultures and especially irrigated rice have been privileged, has shown that the areas next to ricefields are the most dangerous. A supervision and careful maintenance of irrigation systems should also be ensured by particularly avoiding overflowing which produce pools of stagnant waters. Holes out of which earth has been taken for construction should be avoided. Such measures, combined with the use of persistent insecticides in living areas, obviously need effective control. The tragedies which occurred in this region during the last decade (flood of refugees, military operations, etc.) have largely jeopardized the efforts undertaken.

36 There is no doubt that large schemes also have beneficial effects on the health of local population. In some cases they are combined with a social and medical support not existing, at least to the same degree, in the surrounding area. Moreover, the rise of the living standard caused by certain development schemes allows people to have a better medical treatment or even just a better protection from infected vectors, even if these are now more numerous. For instance, in the valley of Kou, in Burkina Faso, the development of flooded ricefields has led to a mosquito proliferation without any malaria upsurge. In fact, as the sale of rice has increased their incomes, farmers could buy mosquito-nets (Mouchet, 1989, p. 377).

37 The expansion of agriculture and the development of pioneer fronts coincide with the spread of certain diseases. Leishmaniasis seems to have followed the clearing of the Amazonian forest in Bolivia. More than 80% of settlers who came to the Alto Beni have caught leishmaniasis L. Braziliensis during the first year of their stay since they had been in touch with the vectors living at the lower level of the thick forest. On the other hand, in the Yungas, the replacement of coffee plantations by coca plantations and food-producing plants has reduced the importance of leishmaniasis itself by eliminating the forest vector associated with coffee trees (Mouchet, 1989, p. 372).

38 Some development projects of public health produced considerable effects on the natural environment and geographical landscapes. The struggle against certain endemic diseases has sometimes led to new national and regional developments. In the 1920s and 1930s, in some regions of the Congo and also of Western Africa, rural habitat was strongly

disrupted because the colonial authorities decided to keep populations out of reach of tsetse flies by moving villages away from rivers, by resettling them often on plateaus and sometimes by taking advantage of this situation to reorganize them into larger entities (Nicolaï, 1963). Sometimes the elected struggle method has resulted in a complete planning and development scheme. A well-known example is that of the Anchau corridor, in central-north Nigeria where the removal of the vegetation favourable to the Glossina and the preservation of this situation in a country of low population density has required the concentration of the inhabitants in one part only of the territory (corridor) in order to reach sufficient density and to deal with this area only. It has been decided to include this operation in a restructuring project of the Hausa countryside by developing larger villages, by designing a geometric field pattern, by trying to stabilize exploitation, by taking advantage of the opportunity to introduce new agricultural techniques (in particular the plough and harnessed culture). Even if only some of these objectives have been achieved, at least the Anchau landscape has been deeply transformed (Nash, 1948).

39 Such heavy operations, which could be carried out only under colonial constraint, have no longer been conceivable. But operations included in an international eradication programme for endemic diseases, particularly onchocerciasis, in inland western Africa, by destroying, through helicopter spreading, the shelters of simulids (Simulium damnosum), i.e. the vector insect, have cleaned wide territories which had been neglected up to now partly because of the presence of the disease and which were decided to be exploited. Let us take for example the development of the valleys in the Volta Basin, in Burkina Faso, including the settlement of new villages, even of populations coming from elsewhere, which have caused a number of problems such as the not always suspected land ownership problems. (Hervouet, 1984; Limbosch, 1984).

The limits of tropical specificity in the problems of public health in the urban environment

40 The health problems related to the city development have a particular feature insofar as they are intensified by the tropical environmental conditions. The lack of a good road maintenance and an adequate water draining system, which results of a chaotic urban growth and inadequate means (in fact a good road maintenance is more costly to achieve in a tropical country due to the heavy and abundant rains), is favourable to the proliferation of vectors and of parasites indirectly. Many examples are found in African but also in Asian towns. (Wanasinghe, 1995).

41 Species and varieties of vectors are rapidly changing according to the environmental pollution by urban waste and according to the city expansion in different ecosystems. The situations vary greatly from one city to another and also from one year to another. In a general way, malaria vectors are seen to decrease in large numbers from the periphery to the centre so that urban paludism seems to be a weakened rural malaria.

42 However, in some Indian towns, an urban malaria, transmitted by Anopheles stephensi, which develops in domestic reservoirs, looks more severe than that of the surrounding rural area.

43 Even if there are breeding places of simulids nearby, the strongest effects of onchocercosis, especially blindness, are less frequent in an urban than in a rural environment as parasites are more diluted among the population. There were shelters of

simulids near Kinshasa and Brazzaville, particularly in the rapids downstream from these neighbouring towns but a powerful DDT treatment, preceded by a study of the habits of these insects, had eradicated them as early as 1948. Later on, even if insecticide spraying was given up, it seems that simulids could not multiply any longer owing to the pollution of their breeding places by urban waste (a lucky effect of pollution!) or else by the development of water hyacinths (a lucky effect of a plant nuisance!) (Henry *et al.*, 1984).

44 On the whole, health problems in tropical cities are less directly related to the tropical environmental conditions than those of rural areas.

45 Moreover, malnutrition, especially proteic, is less serious. However, in such cities like Kinshasa, whose connections with their food-producing hinterland have become more difficult and especially where the economic and political crisis has caused a collapse in the incomes of city dwellers due to the closure of many firms, an upsurge of food problems is going on. Malnutrition is even said to be stronger there than in rural areas. According to a recent inquiry, 13.6% of people would be suffering from acute malnutrition in Kinshasa (R.D. Congo Ministère de la Santé Publique, 1999 p. 52). Recent political events, combined with a serious economic crisis, have increased poverty. They have intensified the supply difficulties not only with food products coming from the hinterland but also with firewood and charcoal. This shortage as well as the high increase in prices have obliged many families to reduce not only the number of daily meals (the large majority of households have no more than one meal a day now) but also the number of warm meals.

46 In the city, the health status of the population is above all the consequence of its poverty and also of the government's failure to create various necessary networks and facilities at an adequate level of public health. However, the access to health services is after all much easier than in the countryside. The mortality rates, especially infant mortality, are definitely lower. Many megacities are located in the intertropical zone. Extended slum areas are related to rapid urban growth. Poverty, inadequate food intake, bad housing conditions, poor hygiene and sanitation are the causes of high levels of infectious and parasitic diseases. On the other hand, the urban life style influenced by westernization involves new health risks (Verhasselt, 1997). Consequences are an increase of chronic illnesses, such as cardio-vascular diseases, neoplasms, diabetes, obesity, hypertension, respiratory diseases (many big cities in the tropical world have high air pollution levels due to traffic and industry), stress and mental illnesses. Hence large cities are facing a twofold pathology: a 'traditional' health pattern dominated by high rates of infectious diseases and a westernized 'modern' health pattern characterized by chronic diseases.

Health problems in the tropical world related to underdevelopment

47 These urban examples demonstrate that the geography of health in tropical countries cannot deal only with endemic or epidemic situations in close relationship with the physical environment. As in the temperate world, it should take into account the socio-economic criteria, and more generally, the civilization criteria and life habits.

48 The cultural aspects of health should be considered with special attention (Gesler, 1991). Particularly interesting is the case of Sub-Saharan Africa. African villagers have traditional health systems which interfere with modern systems. The health

deterioration of a person involves the whole family group, even the clan. This traditional treatment does not prevent the sick person from turning to modern forms of medicine if there is a neighbouring health centre or community clinic equipped with drugs, provided of course that the sick or his family can afford them. In cities, general poverty and the economic recession have led people to turn more and more to traditional healers and even, like in Kinshasa, to healing churches which give them psychological support for the trials suffered (Devisch, 1998).

49 Malnutrition is principally related to poverty. In cities unemployment and lack of income (generally only the informal sector provides some financial support) are responsible for an unbalanced diet.

50 In rural areas high population densities worsen the nutritional situation. This is the case of Kivu in the Congo in the region near Bukavu (Wils *et al.*, 1986) where proteic shortages are frequent in mothers and children. A map of population distribution added to maps of demographic growth rates and of soil quality and land ownership systems could point to risk areas requiring priority interventions (Nicolaï, 1998).

51 An indirect effect of poverty has also been the massive return of diseases that were thought to be overcome, such as tuberculosis. Its re-emergence is known to be often linked to AIDS diffusion. But an effective struggle against this pandemic is made more difficult because of poverty. In Sub-Saharan Africa life expectancy decreased due to AIDS mortality in several countries (e.g. Botswana, Zimbabwe, Zambia) (UNICEF, 2000).

52 Population mobility and forced migrations (due to violence and war situations) have affected many tropical areas, particularly in Africa (Prothero, 1994). As a consequence cholera epidemics broke out (in refugee camps, e.g.), infectious diseases increased on a whole and famine appeared. For example in Sudan mortality due to famine related to military operations was comparable to the figures related to drought some twenty years ago.

53 In tropical areas more attention is being paid to the gender dimension of health. Very often women have specific health risks because of heavy workloads and nutritional imbalance (Bourdier, 1998).

Conclusion

54 Initially, geographers have dealt with the ecological aspects of diseases in a tropical environment and particularly with possible effects related to voluntary or unintentional changes of this environment. They have also studied the effects of human behaviour, of population mobility, of rural and urban life organization, in particular settlement location.

55 The role of geographers in multi-disciplinary health programmes should be strengthened particularly in tropical areas. They are well trained in analyzing the interaction of physical and human factors in disease ecology.

56 Moreover an increased involvement in eradication programmes and input in spatial planning of health care facilities could be enlarged. Health systems research should deserve more attention.

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ABSTRACTS

The relationship between tropical environment and diseases is analysed. On the one hand, specific tropical diseases are related to the natural environment; on the other hand, socio-economic conditions have a large impact. Three examples of re-emerging diseases are examined (malaria, dengue, Chagas' disease). Environmental changes as a consequence of development schemes often lead to increased disease incidence. The urban environment has its own health hazards. The role of underdevelopment and poverty is stressed.

L'article s'interroge d'abord sur la spécificité d'une géographie tropicale de la santé. Certaines maladies ont une répartition typiquement tropicale mais les conditions économiques et sociales jouent un grand rôle dans leur persistance ou leur gravité. D'autre part les pays tropicaux montrent une grande diversité de situations dans le processus de transition épidémiologique. Certaines maladies connaissent une nouvelle émergence. Trois cas sont analysés: ceux de la malaria, de la dengue et de la maladie de Chagas. Parmi les facteurs responsables, il y a l'apparition de chimio-résistance parmi les agents ou les vecteurs de ces maladies, la dégradation des systèmes de santé, les modifications apportées à l'environnement. Les grands aménagements pour le développement peuvent avoir des effets négatifs. L'environnement tropical peut être responsable de problèmes de santé dans les villes mais la pauvreté de la population y est le facteur essentiel. La situation générale est particulièrement grave en Afrique tropicale suite aux effets des événements politiques et militaires (guerres, mouvements de réfugiés) et au développement du SIDA. La lutte contre les endémies tropicales implique des recherches multidisciplinaires dans lesquelles les géographes ont un rôle important à jouer.

INDEX

Mots-clés: géographie de la santé, géographie tropicale, développement, écologie des maladies, maladies en recrudescence
Keywords: geography of health, tropical geography, development, disease ecology, re-emerging diseases

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